Extended Abstract

Panasqueira mine environmental quality evaluation. Soil-Water-*Arbutus unedo*. Social and environmental study case.

Panasqueira mine is one of the last mines still in operation in Portugal. This mine is located at South Estrela Mountain in Beira Interior, 35 km from Fundão, being the greatest producer of tungsten in Europe. Panasqueira mine also produces copper and tin. The exploration has been developed over the last century, when residues of "Lavaria" were dumped in large tailings, which together with water drainage from underground, seepage and effluents from water plant treatment cause a huge visual and chemical impact.

The objective of this study was to access the biogeochemical impact in soil, water and strawberry trees (*Arbutus unedo* L.) due to mining activity. This study evaluates the contamination dispersion from mine plant to the contiguous areas, it also proposes to evaluate the capacity of the strawberry tree to be used in phytostabilization of contaminated soils and tailings, and the use of strawberry fruits to produce alcohol (project in study by São Francisco de Assis and Barroca Grande villages).

For this study, samples of soils (n=15), tailing materials (n=2), strawberry tree leaves and branches (n=13), roots (n=6) and fruits (n=6), waters (n=10) and sediments (n=5) were collected in three different periods (April 2007, November 2007 and March 2008). Soils (10-15 cm deep) were developed on tailings, schists which receive the influence of seepage water and coluvio-alluvion materials (river bank areas). Water samples were collected at Bodelhão stream and Zêzere river. Sediments were also collected in Bodelhão stream. Plant samples (roots, shoots and fruits) were collected in the same places of the sampled soils. Three alcohol samples produced with strawberry fruits picked on contaminated soils (BAL1) and on soils not contaminated (BAL2 and BAL3) were analysed.

Soil samples (fraction< 2 mm) were characterised as follow: pH (H_2O, KCl), cation exchange capacity and exchangeable cations, particle size distribution (Póvoas & Barral, 1992); extractable P and K (Égner-Riehm, 1960); mineral N (Bremmer & Mulvaney, 1982); organic carbon, exchangeable Al (Póvoas & Barral, 1992); Fe oxides (crystalline and not crystalline) (De Endredy, 1963; Schwertmann, 1964, respectively); Mn oxides (Chao, 1972); organic matter (Póvoas & Barral, 1992); enzyme activity (dehydrogenase, Tabatabai, 1994; acid phosphatise, Tabatabai, 1994; β-glucosidase, Tabatabi, 1982; urease, Kandeler & Gerber, 1988; cellulose, Hope & Burns, 1987; protease, Ladd & Butler, 1972). The same soil fraction was analysed for total chemical elements content (60 elements, Actlabs Lab) and bioavailable fraction (extracted with DTPA, $CaNO_3$, $C_2H_7NO_2$). Waste dump material were also analysed for pH and for total chemical elements content (60 elements, Actlabs Lab).

Conductivity, pH, temperature and Eh were measured *in situ* in superficial water and seepage water. Water samples were also analysed for major anions (NO_3^-, Cl^-, F^-, SO_4^{2-}, Br^-).

Aboveground parts (branches, leaves and fruits) and roots of strawberry trees were analysed for total chemical elements content (60 elements, Actlabs Lab). Total content for ten chemical elements (mainly trace elements) was also analysed in alcohol samples.

Pearson correlation coefficients and basic (Microsoft Office Excel 2003) statistics were used for data analysis.

Soils from Panasqueira mine area are acid, with silt loam texture, rich in organic C and extractable K, contain low amounts of exchangeable Al and extractable P and mineral N. Soils also have a high content of iron oxides, with crystalline Fe oxides prevailing over non--crystalline fraction.

Panasqueira soils are highly contaminated with As (680 mg kg^{-1}), Cu (233,3 mg kg^{-1}), Pb (59,6 mg kg^{-1}), Zn (332 mg kg^{-1}), Cd (2,37 mg kg^{-1}), and W (138 mg kg^{-1}) and the chemical elements total content in waste materials (As, Cu, Zn, Cd and W) are also high. Most trace elements occur associated with residual or iron oxides phases. Only copper, lead, manganese and zinc are mostly associated with organic and bioavailable phases, especially on soils affected by seepage water, water station treatment sludge and on colluvio-alluvial soils. DTPA extraction solution was the most effective extracting reagent for the majority of the elements.

Rhyzosphere environment of the strawberry tree was, for most of the elements, more favourable to enzyme activity. But there was, in general, a depress effect on enzyme activity due to total and/or bioavailable fraction of metal and arsenic elements.

The dispersion of elements by transport on solid phases or in solution and adsorbed on sediments was identified by the highest sediments content in As (59696 mg kg^{-1}), Fe (89563 mg kg^{-1}), W (2186 mg kg^{-1}), Cd (24 mg kg^{-1}), Zn (2432 mg kg^{-1}), Pb (20626 mg kg^{-1}), Al (62720 mg kg^{-1}) and S (18582 mg kg^{-1}). Water analyses indicated the low effectiveness of the station water treatment and the dispersion of contaminates in solution (sulphur) to Zêzere river, where due to water dilution, the negative effects of mine activity had a drastic decrease. Bodelhão water is not good for drink and irrigation should be done with precautions.

Strawberry tree should be used in the phytostabilization of tailings and contaminated soils in Panasqueira due to the low trace elements content in aerial parts of the plant. However, cadmium can attain high content in the aerial part of the plants but it does not exceed the toxic limit for cattle (10 mg kg^{-1}). As a consequence there is no danger to biologic systems or accumulation risk on the food chain. *Arbutus unedo* is not an accumulator species, and it is tolerant to trace elements. Aluminium, arsenic, copper, iron, and lead

content absorbed by plants are kept mainly in root tissues. Moreover, this plant is a pioneer species on the natural tailings vegetation, being the first stage of vegetal development.

The strawberry tree is part of Beira Interior's Forest Landscape Planning, as a species with great fire resistance and a good source of alcohol (alcoholic ferment of strawberry fruits). In fact, the fruits collected in the contaminated soils and alcohol analyses allow to conclude that there is no threatening to human health by fruits or alcohol consuming. Therefore, the installation of an alcohol distillery at São Francisco de Assis and Barroca Grande villages can be accomplished. This project can represent a profit from a local product but also create employments in a depressed (economical and socially) region of Portugal.